Attorney Docket No.: TS6196 (US)
A Named Inventor/Application Identifier: Wilhelmus Hubertus Paulus Maria HEIJNEN
Express Mail Label No.: EL645499049US
Title: PIPE CONNECTING METHOD
Date: November 28, 2000

UTILITY PATENT APPLICATION TRANSMITTAL
UNDER 37 CFR 1.53(b)

Assistant Commissioner for Patents
Box Patent Applications
Washington, DC 20231

1. ☒ This application is a(n):

   a. ☒ Original
   b. ☐ Continuation-in-part of Application Serial No. _____ filed _____
   c. ☐ Divisional of Application Serial No. _____ filed _____
      ☐ Applicant(s) elect the invention of Group/Species _____
   d. ☐ Continuation of Application Serial No. _____ filed _____

2. ☒ Specification

   a. ☒ Pages 8
   b. ☒ Drawings, Total sheets 1

3. ☒ Oath or Declaration

   a. ☐ Newly executed (original or copy)
   b. ☐ Copy from a prior application
      ☐ Please delete the following named inventors in the prior application: _____

4. ☐ Please amend the specification

   a. ☐ By inserting before the first line:
      This is a ☐ continuation ☐ division ☐ continuation-in-part of Application Serial No. _____ filed _____, the entire disclosure of which is hereby incorporated by reference
   b. ☐ By inserting before the first line:
      This application claims the benefit of U.S. Provisional Application No. ____ _____ filed _____, the entire disclosure of which is hereby incorporated by reference
   c. ☐ Cancel claims _____

5. ☒ This application claims the benefit of Application Number 99309531.4 filed on November 29, 1999 in Europe under 35 U.S.C. § 119, § 365(a), or § 365(b). (For originals)

6. ☐ Microfiche Computer Program (Appendix)

7. ☐ Recognize as an associate attorney _____, Registration No. _____

8. ☒ Address all future communications to:

Del S. Christensen
Shell Oil Company
Legal – Intellectual Property
P. O. Box 2463
Houston, Texas 77252-2463

9. ☒ Fee Transmittal (duplicate enclosed)

(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
TOTAL CLAIMS (37 CFR 1.16(c))	10 - 20 =	0	X $18.00 =	$000.00
INDEPENDENT CLAIMS (37 CFR 1.16(b))	2 - 3 =	0	X $80.00 =	000.00
MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))	0		+ $270.00 =	000.00
			BASIC FEE (37 CFR 1.16(a))	$710.00
			Total of above Calculations =	0.00
			TOTAL =	$710.00

10. ☒ Please charge Deposit Account No. 19-1800 in the amount of $710.00.

11. ☒ The Assistant Commissioner is authorized to charge all additional required fees or to credit overpayments, to Deposit Account No. 19-1800, including fees required under 37 CFR 1.17

12. ☒ Accompanying Application Parts

a. ☐ Recordal of Assignment and Assignment
b. ☐ Information Disclosure Statement/PTO-1449
c. ☐ Preliminary Amendment
d. ☒ A self-addressed, stamped return receipt postcard to be returned with the filing date and Serial No. thereon
e. ☐ Certified copy of priority documents

Respectfully submitted,

Wilhelmus Hubertus Paulus Maria HEIJNEN

By _____
Attorney, Del S. Christensen
Registration No. 33,482
(713) 241-3997

P. O. Box 2463
Houston, Texas 77252-2463

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PIPE CONNECTING METHOD

The present invention relates to a method of connecting pipes. These pipes can be sections of a pipeline or well tubulars that are used in a well for producing hydrocarbons from an underground reservoir.

In particular the method is used in connection with interconnecting casing strings or liners. The casing string is a string of steel pipe sections that is used to line a borehole extending through an underground formation, and that is secured to the formation by means of cement. In a single well there may be two or more casing strings, wherein the upper end of the next casing string is hung off from the lower end of the preceding casing string. In order to be able to bring the next casing string into place, the outer diameter of the next casing string has to be smaller than the inner diameter of the preceding casing string. The next casing string may also be a so-called liner. In the specification the expression 'casing string' will also be used to refer to a liner.

Nowadays there are techniques that allow enlarging the diameter of a casing string when it is in the borehole. However, these techniques do not allow expanding the connection where the next casing string is hung off from the previous casing string.

Thus there is a need to provide a method that enables connecting a first pipe to a second pipe such that the inner diameter at the connection is not less than the

inner diameter of the second pipe and that the pipes are adequately sealed at the connection.

In accordance with the invention there is provided a method of connecting a first pipe to a second pipe having an end part fitting into an end part of the first pipe, comprising

a) arranging the end part of the second pipe within the end part of the first pipe;

b) arranging a sleeve of a deformable material between said end parts; and

c) radially expanding the end part of the second pipe towards the end part of the first pipe so as to bias the sleeve between said end parts.

By biasing the sleeve of deformable material between the end parts an adequate seal is achieved between the pipes.

The sleeve can for example be made of a hard elastomer or a ductile metal, however it is preferred that the sleeve is made of a shape-memory alloy so that the sleeve is expandable upon heating of the sleeve to the transition temperature of the shape-memory alloy, and wherein the method further comprises:

d) after step c), heating the sleeve to the transition temperature of the shape-memory alloy thereby expanding the sleeve to form a metal-to-metal seal between said end parts.

Suitably two said shape-memory alloy sleeves are arranged concentrically between said end parts, one of the sleeves being connected to the outer surface of the end part of the second pipe, and the other sleeve being connected to the inner surface of the end part of the first pipe, and wherein after step c) each sleeve is

heated to the transition temperature of the shape-memory alloy thereby expanding the sleeves to form a metal-to-metal seal between said end parts.

Preferably each sleeve is expandable by virtue of an increase of the wall thickness of the sleeve upon heating of the sleeve to the transition temperature of the shape-memory alloy.

The invention will now be described by way of example in more detail with reference to the accompanying drawing showing schematically a partial longitudinal section of the device 10 according to the present invention in a position in which it can connect the first end of a second pipe in the form of the top end 15 of a next casing string 16 to the second end of a first pipe in the form of the bottom end 20 a preceding casing string 21. The bottom end 20 is provided with an anvil section 23.

The casing strings 16 and 21 are arranged in a borehole (not shown) drilled in the underground formation, and the preceding casing string 21 is secured to the formation by means of cement (not shown). In order that the next casing string can be lowered through the preceding one, its outer diameter is smaller than the inner diameter of the preceding casing string 21.

The device 10 comprises a cylindrical body 30 provided with an annular shoulder 32 for positioning the device 10 at the top end 15 of the next casing string 16. The device 10 is lowered into the preceding casing string 21 at the lower end of a drill string 31, of which the lower end is connected to the upper end of the cylindrical body 30.

The cylindrical body 30 is provided with an annular recess 34, in which annular recess 34 is arranged an

explosive charge 37, which explosive charge 37 is covered by a protective sleeve 38. The cylindrical body 30 further comprises a device 40 for detonating the explosive charge 37. The device 40 for detonating the explosive charge is activated from surface by passing a signal through a cable 41 that extends to surface. The detonation is passed from the detonator 40 to the explosive charge 34 by transfer conduit 42.

During normal operation, the device 10 is brought into position as shown in the drawing, and the device 40 for detonating the explosive charge 37 is activated. The explosion of the explosive charge 37 causes the top end 15 of the next casing string 16 to deform. The anvil section 23 of the bottom end 20 of the preceding casing string 21 prevents further expansion of the top end 15, and thus the two casing strings are interconnected. After having made the connection the device 10 is pulled out of the well.

In order to improve the strength of the connection the anvil section 23 is provided with an annular recess 45.

In order to improve the sealing of the connection, a sleeve of shape-memory alloy (not shown) is provided on the outer surface of the first end of the second pipe and on the inner surface of anvil section, wherein the shape-memory alloy expands on heating to provide a metal-to-metal seal. Alternatively, the seal can also be a hard elastomeric part or a metal part.

The inner diameter of the anvil section can be so selected that the inner diameter of the second pipe (after expansion) is substantially equal to the inner diameter of the first pipe. Moreover, with known

techniques the second pipe can be expanded over its full length, so that its inner diameter is not less than the inner diameter of the first pipe.

Thus the use of device according to the present invention allows a connection such that the inner diameter at the connection is substantial equal to the inner diameter of the first pipe.

C L A I M S

1. A method of connecting a first pipe to a second pipe having an end part fitting into an end part of the first pipe, comprising

a) arranging the end part of the second pipe within the end part of the first pipe;

b) arranging a sleeve of a deformable material between said end parts; and

c) radially expanding the end part of the second pipe towards the end part of the first pipe so as to bias the sleeve between said end parts.

2. The method of claim 1, wherein the sleeve is made of a hard elastomer or a ductile metal.

3. The method of claim 1, wherein the sleeve is made of a shape-memory alloy so that the sleeve is expandable upon heating of the sleeve to the transition temperature of the shape-memory alloy, and wherein the method further comprises:

d) after step c), heating the sleeve to the transition temperature of the shape-memory alloy thereby expanding the sleeve to form a metal-to-metal seal between said end parts.

4. The method of claim 3, wherein two said shape-memory alloy sleeves are arranged concentrically between said end parts, one of the sleeves being connected to the outer surface of the end part of the second pipe, and the other sleeve being connected to the inner surface of the end part of the first pipe, and wherein after step c)

each sleeve is heated to the transition temperature of the shape-memory alloy thereby expanding the sleeves to form a metal-to-metal seal between said end parts.

5. The method of claim 4, wherein each sleeve is expandable by virtue of an increase of the wall thickness of the sleeve upon heating of the sleeve to the transition temperature of the shape-memory alloy.

6. The method of claim 5, wherein the inner surface of the end part of the first pipe is provided with an annular recess.

7. The method of claim 5, wherein step c) comprises installing a device provided with an explosive charge in the end part of the second pipe, and detonating the explosive charge.

8. The method of claim 7, wherein said device comprises a cylindrical body provided with an annular shoulder for positioning the device against the end part of the second pipe, and an annular recess in which the explosive charge is arranged.

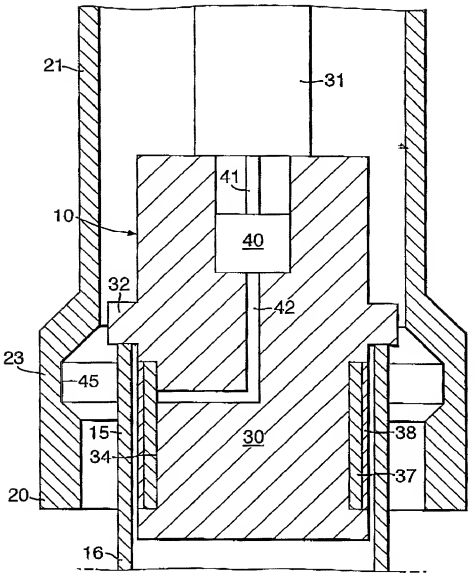
9. The method of claim 8, wherein the first pipe is an upper wellbore casing and the second pipe is a lower wellbore casing.

10. The method substantially as described hereinbefore with reference to the drawing.

A B S T R A C T

PIPE CONNECTING METHOD

A method of connecting a first pipe to a second pipe having an end part fitting into an end part of the first pipe, comprising arranging the end part of the second pipe within the end part of the first pipe, arranging a sleeve of a deformable material between said end parts, and radially expanding the end part of the second pipe towards the end part of the first pipe so as to bias the sleeve between said end parts.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ATTORNEY'S DOCKET NO.
TS6196 (US)

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled LEAK DETECTION METHOD the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____ as United States Application Number or PCT International Application Number _____ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 27 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN APPLICATION(S)

APPLICATION NUMBER	COUNTRY	DAY/MONTH/YEAR FILED	Priority Not Claimed
99309531.4	**Europe**	**29/11/99**	☐
APPLICATION NUMBER	COUNTRY	DAY/MONTH/YEAR FILED	☐

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below.

APPLICATION SERIAL NO.	FILING DATE
APPLICATION SERIAL NO.	FILING DATE

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT International application designating the United States, listed below and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

APPLICATION SERIAL NO.	FILING DATE	STATUS-PATENTED, PENDING, ABANDONED
APPLICATION SERIAL NO.	FILING DATE	STATUS-PATENTED, PENDING, ABANDONED

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

NAME	ATTORNEY/AGENT	REGISTRATION NUMBER	TELEPHONE NUMBER
Eugene R. Montalvo	Attorney	32,790	(713) 241-0296
NAME	ATTORNEY/AGENT	REGISTRATION NUMBER	TELEPHONE NUMBER
Richard F. Lemuth	Attorney	30,081	(713) 241-3921

Revised June 1995

SEND CORRESPONDENCE TO:

(NAME) Eugene R. Montalvo
c/o Shell Oil Company
Intellectual Property
P.O. Box 2463
Houston, TX 77252-2463

ATTORNEY'S DOCKET NO.
TS6196 (US)

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF SOLE OR FIRST INVENTOR (given name, family name)
Wilhelmus Hubertus Paulus Maria HEIJNEN

INVENTOR'S SIGNATURE — DATE SIGNED

RESIDENCE — CITIZENSHIP
Elwerathstrasse 1, D-29336 Nienhagen, Germany — **Netherlands**

POST OFFICE ADDRESS
Elwerathstrasse 1, D-29336 Nienhagen, Germany

FULL NAME OF SECOND JOINT INVENTOR, IF ANY (given name, family name)

SECOND INVENTOR'S SIGNATURE — DATE SIGNED

RESIDENCE — CITIZENSHIP

POST OFFICE ADDRESS

FULL NAME OF THIRD JOINT INVENTOR, IF ANY (given name, family name)

THIRD INVENTOR'S SIGNATURE — DATE SIGNED

RESIDENCE — CITIZENSHIP

POST OFFICE ADDRESS

FULL NAME OF FOURTH JOINT INVENTOR, IF ANY (given name, family name)

FOURTH INVENTOR'S SIGNATURE — DATE SIGNED

RESIDENCE — CITIZENSHIP

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